

# THE GENUS *ARCHILEJEUNEA* (SPRUCE) SCHIFFN. IN INDIA\*

RAM UDAR AND U. S. AWASTHI

*Department of Botany, University of Lucknow, Lucknow\*\**

## ABSTRACT

The paper deals with the present status of the genus *Archilejeunea* (Spruce) Schiffn. in India. Four species viz., *A. apiculifolia* St. and *A. indica* St. from south India and *A. sikkimensis* St. and *A. turgida* (Mitt.) St. from eastern Himalayas had been earlier described out of which *A. sikkimensis* and *A. turgida* were subsequently transferred to the genus *Leucojeunea* Evans—a view which has been confirmed from a study of their type specimens. Our study reveals that *A. indica* should belong to the genus *Schiffneriojeunea* Verd. and *A. apiculifolia*, formerly reduced to synonymy under *A. mariana* (Gott.) St., is a genuine taxon. A new species, *A. minutilobula* sp. nov., has been described from south India. In the present state of our knowledge the genus *Archilejeunea* is represented by two species in Indian bryoflora : *A. apiculifolia* and *A. minutilobula*.

## INTRODUCTION

In a recent circumscription of the taxa belonging to the sub-family Ptychanthoideae Mizut. (of the large family Lejeuneaceae) GRADSTEIN (1975) has treated 20 genera referring them to two tribes : Ptychantheae and Archilejeuneae. In the former, which includes the genera belonging to *Ptychanthus*, *Caudalejeunea* and *Brachiolejeunea* complexes, the leaves when dry are more or less convoluted and suberect but widely spreading when moist. The cells of the leaf are elongated and are arranged in more or less diverging rows and have cordate trigones. In the latter which includes the genera belonging to *Dicranolejeunea*, *Lopholejeunea*, *Archilejeunea* and *Stictolejeunea* complexes, the leaves are widely spreading and flat or involuted under dry condition. The leaf cells are isodiametric and have trigones which are simple—triangular with straight or equally bulging sides, or radiate, or rarely slightly cordate.

The significant features of the genus *Archilejeunea* of this complex (see GRADSTEIN, 1975) are : The plants lack secondary pigmentation. The branching is of *Lejeunea*-type. In cross-section of the stem the dorsal cortical cells are not larger than the medullary cells. The ventral merophyte is at least 4 cells wide. The leaves are widely spreading and the cells are isodiametric with simple-triangular to radiate trigones. The oil-bodies are segmented. SCHUSTER AND HATTORI (1954) had reported homogeneous oil-bodies in *A. kiushiana* (Horik.) Verd., which according to GRADSTEIN (1975) should possibly be transferred to the closely allied genus *Spruceanthus* Verd. characterized by such oil-bodies. Subsequently however, SCHUSTER (1963) reported segmented oil-bodies too. UDAR AND NATH (1977) also reported segmented oil-bodies in *A. apiculifolia* St. which had, however, been treated by them as *Tuzibeanthus chinensis* (St.) Mizut. The ocelli and the disciform gemmae are absent. The male bracts are "hypostatic" (the free margin of the older bract-lobule overlaps the younger bract). The perianth has 2-5 ventral plicae. The subfloral innovation is invariably present. The sporeling is of *Lopholejeunea*-type.

\*Paper presented at the 3rd Indian Geophytological Conference, Lucknow, December, 1979.

\*\*Contribution from the Department of Botany, University of Lucknow, Lucknow. New Series (Bryophyta)

The genus *Archilejeunea* shows maximum representation in the tropics. In India it has so far received no attention since the report of four taxa by STEPHANI (1909—1912 ; 1917—1924). These are : *A. apiculifolia* St. and *A. indica* St. from south India, *A. sikkimensis* St. and *A. turgida* (Mitt.) St. from eastern Himalayas. Of the above, *A. turgida* and *A. sikkimensis* were subsequently transferred to the genus *Leucolejeunea* Evans (VERDOORN, 1934, see also MIZUTANI, 1976)—a view which finds confirmation from an examination of the type specimens of these two species by us. *A. apiculifolia* was treated as a synonym of *A. mariana* (Gott.) St. (VERDOORN, 1934) which, however, judging from the descriptions and illustrations provided (AMAKAWA, 1964; STEPHANI, 1909—1912 ; 1917—1924 ; Icones Ineditae page no. 7349, 7396) as well as after study of the specimens, is a genuine taxon.

Relevant to the present communication (for evaluating the status of *Archilejeunea indica*) is the treatment of the genus *Ptychocoleus* Trev. *sensu* Evans (see EVANS, 1908) which has been split by GRADSTEIN (1975) into two genera : *Acrolejeunea* (Spruce) Schiffn. and *Schiffneriolejeunea* Verd. The significant differences between these genera as pointed out by GRADSTEIN (1974 ; 1975) are : The stem in *Acrolejeunea* is delicate and has thin-walled pale cortical cells. The medullary cells have wide ends. The stem in *Schiffneriolejeunea* is rigid and has thick-walled cortical cells which become brownish (especially ventrally). The medullary cells are tapering to narrow ends. The oil-bodies in *Acrolejeunea* are homogeneous while in *Schiffneriolejeunea* they are segmented. The male bracts in *Acrolejeunea* are weakly saccate and have "epistatic" lobule (the free margin of the lobule is overlapped by the younger bract). Each bract has single antheridium. In *Schiffneriolejeunea* the male bracts are strongly saccate and have "hypostatic" lobule (the free margin of the lobule overlaps the younger bract). Each bract has 2(-3) antheridia. The perianth consists of 5-12 keels and plicae in *Acrolejeunea* while in *Schiffneriolejeunea* it is 0-5 keeled. Further, the seta which is articulated in *Schiffneriolejeunea* is non-articulated in *Acrolejeunea*.

A critical evaluation of all these characters (except for the oil-bodies) in the fertile plants, approaching the type of *Archilejeunea indica*, collected by Prof. A. R. Rao from the type locality (Mangalore), indicates that *A. indica* should belong to the genus *Schiffneriolejeunea*. These fertile plants were also found to be lacking in subfloral innovation which is present in *Archilejeunea* but absent in *Schiffneriolejeunea*. Also, the cells in the outer layer of capsule wall were found to be having intermediate nodular thickenings in addition to that present at the corners. The intermediate nodular thickenings are lacking in *Archilejeunea* (see MIZUTANI, 1961). Thus *A. indica* should now be placed under the following combination : *Schiffneriolejeunea indica* (St.) Udar *et* Awasthi comb. nov., Syn : *Archilejeunea indica* St. *Sp. Hepat.* 4 : 728, 1909-1912, Geneve.

A new species of *Archilejeunea*, *A. minutilobula* sp. nov., was discovered while examining a collection of liverworts from Mettupalaiyam, south India. The paper gives taxonomic details of *A. apiculifolia* and of the newly discovered species. In the present state of our knowledge only these two species are referable to this genus in Indian bryoflora.

#### MATERIAL AND METHOD

The plants of *Archilejeunea apiculifolia* were collected by R. Udar and party on way to Avalanche, (January, 1972), south India and that of *A. minutilobula* sp. nov. were collected by R. Udar and S. C. Srivastava from Mettupalaiyam (December, 1965) and Mahabaleshwar (March, 1967), south India. The type specimens of *A. apiculifolia* St. (G14994), *A. indica* St. (G14999), *A. sikkimensis* St. (G11907) and *A. turgida* (Mitt.) St. (G11908), obtained from Conservatoire *et* Jardin Botaniques, Switzerland, have also been examined.

Dried herbarium specimens were soaked in warm water for proper stretching. Hoyer's solution and 70 per cent glycerine were used as mounting media.

#### TAXONOMIC DESCRIPTION

#### **Archilejeunea apiculifolia** St. (Text-figs. 1—17)

Syn. *Tuzibeanthus chinensis* (St.) Mizut. (Udar & Nath, 1977) non *Tuzibeanthus chinensis* (St.) Mizut. J. Hattori bot. Lab. **21** : 151 (1961).

*Description*—Monoecious. Plants green or greenish brown, branching intercalary, cross-section of the stem 0.10-0.11 mm × 0.12-0.13 mm, with ca 16 cortical cells, and ca 32 medullary cells, cortical cells equal or slightly larger than medullary cells, cells thick-walled with distinct trigones. Leaves incubous, widely spreading, oblong or ovate-oblong, 0.72-1.0 mm long, 0.48-0.64 mm wide, antical margin broadly arched, postical margin notched at apex of the lobule, margin entire, apex apiculate, occasionally obtuse-rounded, cells with distinct trigones and intermediate nodular thickenings, often extended on the radial and transverse walls, marginal cells 8-18 μm × 10-14 μm, median cells 16-20 μm × 12-20 μm, basal cells 24-36 μm × 16-20 μm. Oil-bodies 6-11 in each cell of the leaf, ovate or elliptical, 4-5 μm long, 2-3 μm wide, segmented; lobule small, 1/3-1/4 of the lobe, 0.20-0.28 mm long, 0.12-0.18 mm wide, with indistinct tooth, free margin slightly or not involuted. Underleaves orbicular, 0.29-0.51 mm long, 0.36-0.56 mm wide with margin entire or slightly wavy, lateral margin constricted towards the base. Male plants with 4-8 pairs of bracts, bracts usually intercalary in position, 0.54-0.69 mm (—0.79 mm) long, 0.36-0.43 mm wide, oblong or ovate-oblong, apex usually rounded or obtuse, occasionally acute, margin entire; lobule 0.36-0.43 mm × 0.18-0.27 mm with apex obtuse or more or less rounded, margin entire-wavy; bracteoles present throughout, 0.22-0.36 mm long, 0.25-0.40 mm wide, margin entire or entire-wavy. Female inflorescence terminal on an elongated branch, usually with one subfloral innovation; bracts smaller than perianth, 0.90-0.97 mm long, 0.47-0.58 mm wide, oblong or oblong-ovate, with margin entire or entire-wavy, antical margin convex; lobule 0.47-0.50 mm long, 0.14-0.22 mm wide, adnate with lobe for about 1/3-1/2 of the length, margin entire or entire-wavy, apex obtuse or acute; bracteoles 0.80-0.97 mm long, 0.60-0.68 mm wide, obovate, with entire or entire-wavy margin; perianth obovate, about 1.28-1.40 mm long, 0.70-0.80 mm wide, four keeled, keels smooth and sharp, with a small beak at apex. Rest not seen.

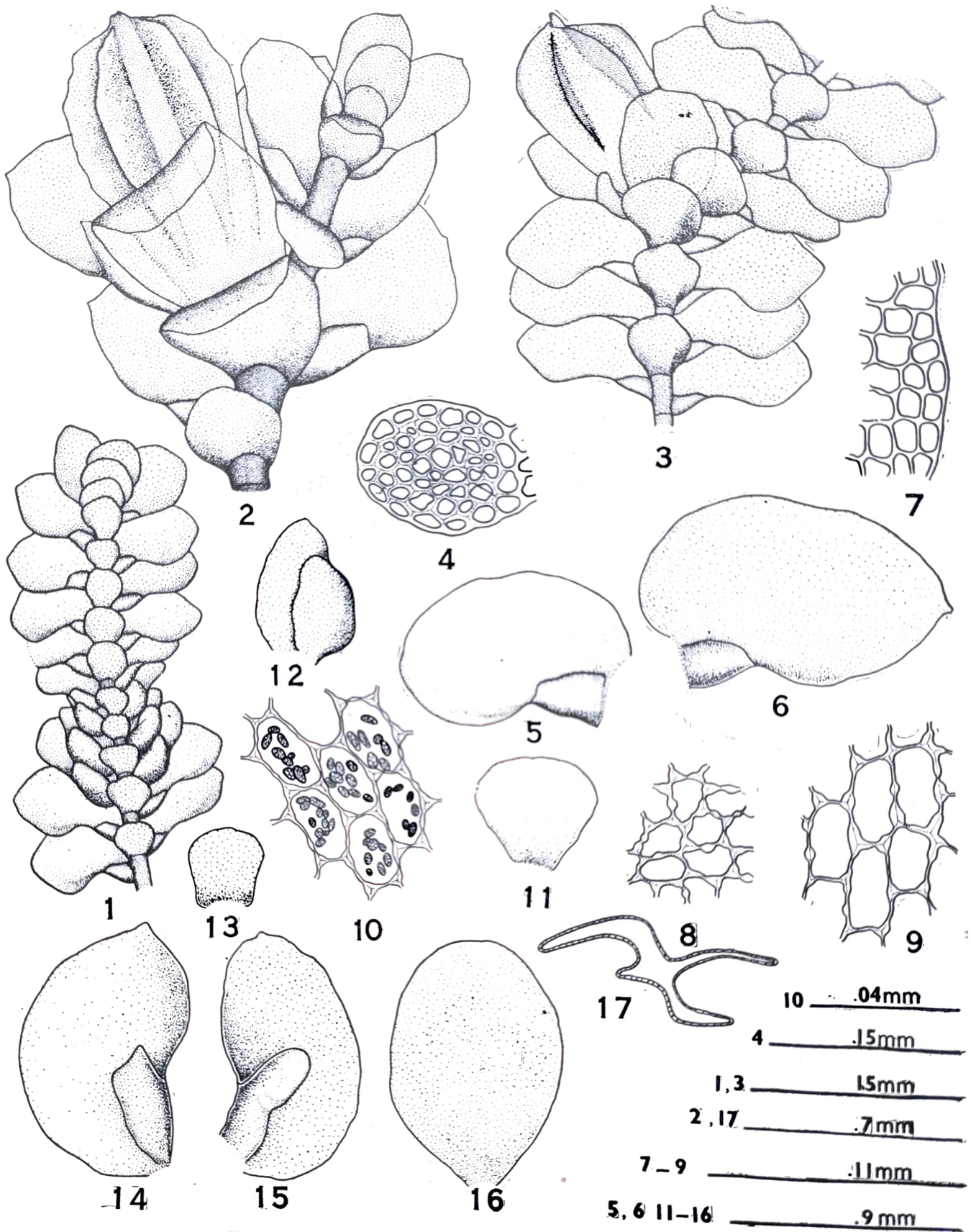
*Specimens examined*—LWU, No. 73 S/A, *Archilejeunea apiculifolia* St. Coll. R. Udar. Loc. On way to Avalanche (alt. 2,439 m) south India, January 2, 1972. Det. R. Udar and U. S. Awasthi.

Type G 14994, Coll. Pflleiderer. Loc. Kudremukh, India orientalis, April 1911. Det. Stephani.

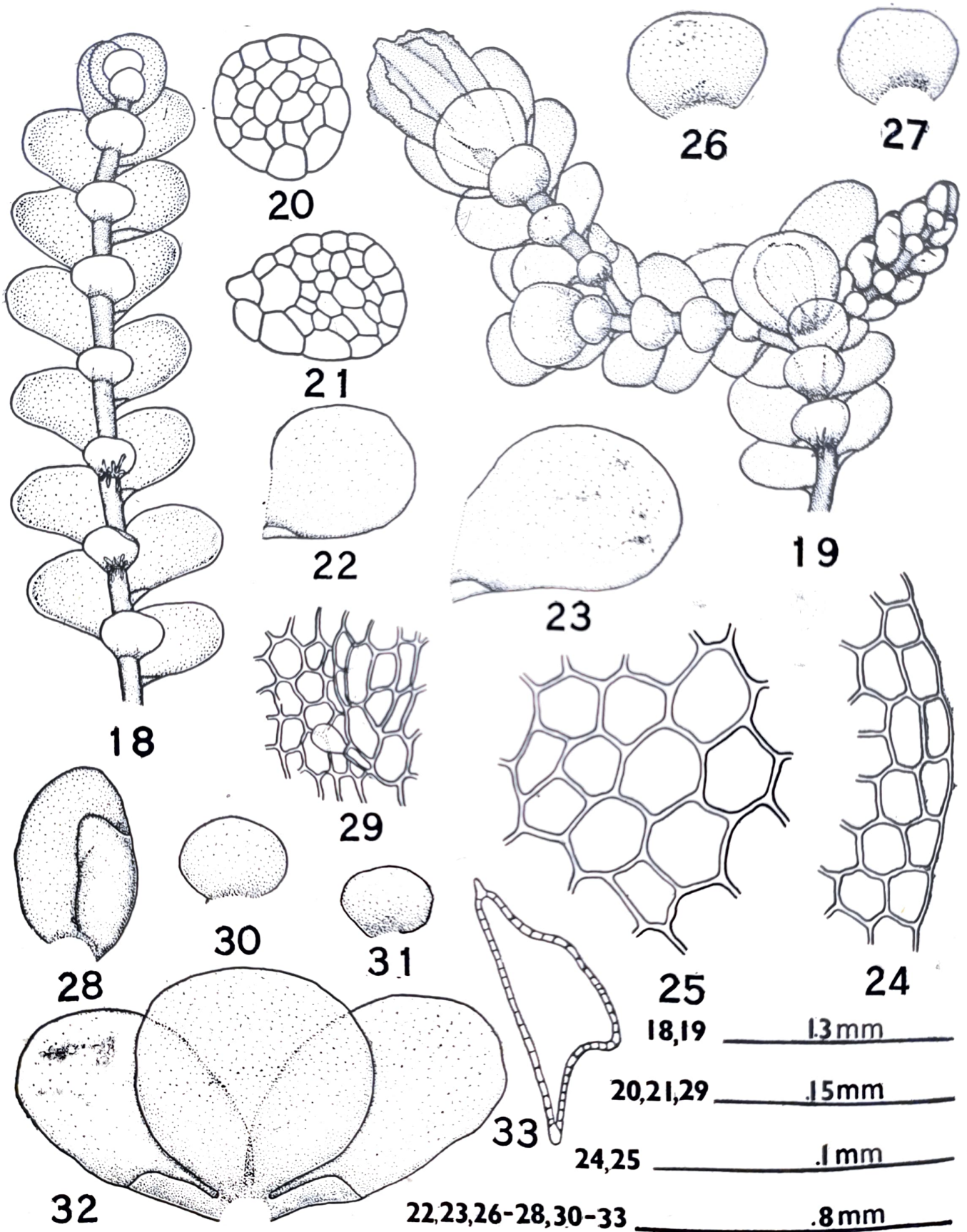
#### DISCUSSION

The specimens 73 S/A are similar to the type specimens of *A. apiculifolia* (G14994) in their overall features.

*A. apiculifolia*, treated as a synonym under *A. mariana* (see VERDOORN, 1934) shows similar characters in the leaf-lobule having indistinct tooth, intercalary male inflorescence, monoecious sexuality and the shape of female bracts and bracteole. However, it differs from the latter in having leaves which are mostly apiculate and only occasionally rounded at apex while the same in *A. mariana* are with rounded or occasionally with obtuse apices.

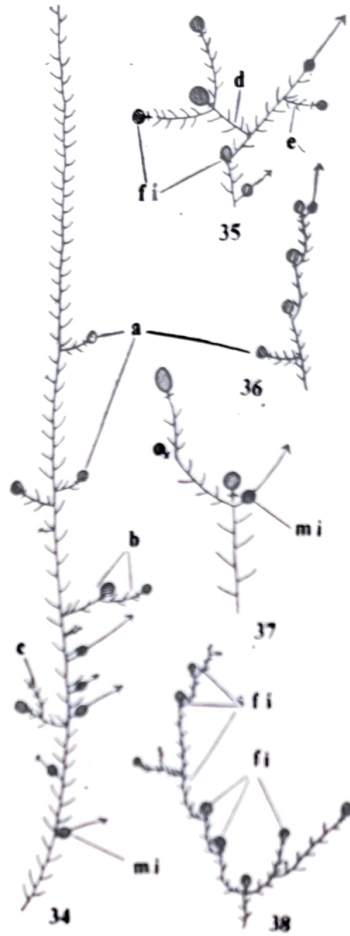


Text-figs. 1-17—*Archilejeunea apiculifolia* St. 1. Portion of the male plant showing intercalary position of bracts and bracteoles; 2. Portion of the female plant showing slightly crenulated margin of the perianth keels (from type specimen, G 14994), 3. Portion of the female plant showing one subfloral innovation; 4. Cross-section of the stem; 5, 6. Leaves; 7. Marginal cells of the leaf; 8. Median cells of the leaf; 9. Basal cells of the leaf; 10. Oil-bodies; 11. Underleaf; 12. Male bract; 13. Male bracteole; 14, 15. Female bracts; 16. Female bracteole; 17. Cross-section of the perianth.



Text-figs. 18-33—*Archilejeunea minutilobula* sp. nov. 18. Portion of the vegetative branch showing perianth and a male branch as subfloral innovation; 19. Portion of the fertile branch showing perianth and a male branch as subfloral innovation; 20, 21. Cross-sections of the stem; 22, 23. Leaves; 24. Marginal cells of the leaf; 25. Basal cells of the leaf; 26, 27. Male bract, margin; 28. Male bract; 29. Portion of the lobule of the male bract showing hyaline papilla at the section of the perianth; 30-31. Male bracteoles; 32. Female bracts and bracteole showing basal attachment; 33. Cross-section of the perianth.

Further the leaf-lobe and lobule ratio is almost 3-4 : 1 in *A. apiculifolia* while 2-3 : 1 in *A. mariana*. These features are sufficiently stabilized in the two taxa which should, therefore, have independent status.



Text-figs. 34-38—*Archilejeunea minutilobula* sp. nov. Diagrammatic representation of the plants showing position of male and female inflorescences.

mi= male inflorescence ; fi= female inflorescence ; sfi= subfloral innovation ; a= female branch lacking subfloral innovation ; b= female branch with subfloral innovation ; c= female branch showing a vegetative branch ; d= female branch showing two subfloral innovations.

***Archilejeunea minutilobula* Udar et Awasthi sp. nov. (Text-figs. 18-33; 34-38)**

*Diagnosis*—Plantae monoeciae ; caulis plerumque 0.08-0.09 mm diam. e seriebus verticalibus cellularum corticalium 11-14, medullosarum 14-17 constitutus; folia oblonga (0.40-0.52 × 0.32-0.38 mm) vel plus minus quadrata (0.32-0.36 × 0.30-0.34 mm); plerumque ad apicem rotundata; lobulus 0.08-0.12 (-0.20) × 0.03-0.04 mm, indistincte dentatus ; folia inferioria 0.16-0.20 mm longa, 0.24-0.32 mm lata; ramus masculinus e paribus bractearum 5-8 (-13), bracteolarum 5-8 (-13) paratus, bracteis 0.34-0.44 mm longis, 0.24-0.30 mm latis, ad apicem obtusis; lobulus .24-.34 mm longus, 0.12-0.15 mm latus, ad apicem obtusus ; bracteolae in forma foliis inferioribus similes 0.14-0.18 mm longae, 0.21-0.28 mm latae; bracteae et bracteolae femineae in longitudine circa dimidium ad apicem rotundatis, bracteis 0.56-0.62- (.78) mm longis, 0.38-0.42 mm latis, obovatis angulatus, ad lobum adnatus ; bracteolae rotundatae 0.52-0.56 mm longae et latae; perianthium obovatum carinis 4 crenulato-marginatis praeditum.

*Holotype*—LWU, sub numero 200/65 *Archilejeunea minutilobula* Udar et Awasthi sp. nov. Leg. R. Udar et S. C. Srivastava. Loc. Mettupalaiyam (alt. ca 500 m) south India, mense December 28, 1965. Det. R. Udar et U. S. Awasthi.

*Description*—Plants green or greenish brown, branching intercalary, cross-section of the stem ca 0.07 × 0.11 mm or 0.08-0.09 mm in diameter with 11-14 cortical cells and 14-17 medullary cells, cortical cells slightly larger or almost equal to the medullary cells, cells thick walled, without trigones. Leaves incubous, obliquely—widely spreading, compactly or distantly arranged, oblong 0.40-0.52 mm long, 0.32-0.38 mm wide or more or less quadrate (0.32-0.36 mm × 0.30-0.34 mm), margin entire, apex rounded or occasionally obtuse; cells with indistinct trigones and intermediate nodular thickenings, marginal cells 10-16 μm × 12-20 μm, median cells 16-28 μm × 16-26 μm, basal cells 20-36 μm × 12-28 μm; lobule small, 0.08-0.12 mm (—0.20 mm) long, .03-.04 mm wide, tooth indistinct or reduced. Underleaves 0.16-0.20 mm long, 0.24-0.32 mm wide, reniform with entire margin. Male inflorescence terminal on short lateral branch, occasionally subfloral, may often form basal or intercalary vegetative branches, bracts in 5-8 (—13) pairs, lobe 0.34-0.44 mm long, 0.24-0.30 mm wide, margin entire, apex obtuse, lobule 0.24-0.34 mm long, 0.12-0.15 mm wide, margin entire, apex obtuse, adnate with the lobe for about 5/6 of its length, occasionally with a hyaline papilla at the base of its free margin, marginal cells almost equal to the rest cells, bracteoles 5-8 (—13), present throughout, similar to underleaves in shape, 0.14-0.18 mm long, 0.21-0.28 mm wide, with entire margin. Female inflorescence terminal on short lateral branch or on elongated branch, usually with one, occasionally with two or even without innovation, bracts and bracteoles about 1/2 the length of the perianth; bracts 0.56-0.62 (—0.78) mm long, 0.38-0.42 mm wide, obovate, margin entire or entire—wavy, with apex rounded, lobule 0.20-0.34 mm long, 0.05-0.08 mm wide, narrowly rectangular, entirely adnate with the lobe, apex rounded—obtuse; bracteoles, 0.52-0.56 mm long and broad, obovate with margin entire, adnate with bract-lobule at the base; perianth 0.80-1.00 mm long, 0.044-0.62 mm wide, obovate with short beak and distinct four keels, keels winged with crenulate margin.

*Holotype*—LWU, No. 200/65. *Archilejeunea minutilobula* Udar et. Awasthi sp. nov. Coll. R. Udar and S. C. Srivastava. Loc. Mettupalaiyam (alt. ca 500 m), south India, December 28, 1965. Det. R. Udar and U. S. Awasthi.

LWU, No. 310/67. Coll. R. Udar and S. C. Srivastava; Loc. Mahabaleshwar (alt. 1,439 m), south India, March 3, 1967. Det. R. Udar and U. S. Awasthi.

#### DISCUSSION

*Archilejeunea minutilobula* is interesting with regard to the leaf-lobule (Text-figs. 22, 23) which is considerably abbreviated and constitutes a conspicuous character. Further, trigones and intermediate thickenings of the leaf cells are indistinct (Text-fig. 25) as compared to most of the other species of the genus, and in cross-section of the stem the cells are uniformly thickened and do not show trigones (Text-figs. 20, 21). The above species is further interesting with regard to the disposition of male and female inflorescences. The main stem continues to grow producing lateral vegetative, male and female branches (Text-fig. 34). The female branch after producing 1-3 pairs of leaves terminates into a female inflorescence which may or may not innovate (Text-figs. 34a, b). Innovation, if present, may terminate into a second inflorescence (Text-fig. 34b). Sometimes a sterile branch develops from a female branch (Text-fig. 34c). In a population there also occur some smaller plants, which show various other patterns of disposition of inflorescences (Text-figs. 35—38). Such a plant may, in most of the cases, after producing 2-3 pairs

of leaves, develops a female inflorescence and 1-2 subfloral innovations which in turn terminate into a female inflorescence (Text-fig. 38) or one of them may remain sterile or sometimes may develop as a male branch (Text-fig. 37). The second inflorescence often innovates again and ends into a third inflorescence. Sometimes this phenomenon continues up to the formation of 5th inflorescence (Text-fig. 38) and it is often interesting to note that almost all innovations are formed either towards left or towards right (Text-fig. 36, 38). Sometimes (Text-fig. 35) the main axis bears at its very base a male branch and then, after giving rise to 2-3 pairs of leaves, terminates into a female inflorescence which innovates to one side. The innovation gives rise to 2 lateral female branches before terminating into a male inflorescence. The first female branch (Text-fig. 35d) bears at its apex a female inflorescence with two subfloral innovations. They develop at their apices female inflorescences which do not innovate further. The second female branch (Text-fig. 35e) terminates into a female inflorescence which does not innovate. Apart from these variations, selected at random from the population, it was also interesting to note that in some specimens of the same population the perianth of the third inflorescence was well developed and almost double the length of the bracts while those of second and first were reduced and even smaller than the length of the bracts (Text-fig. 19).

#### ACKNOWLEDGEMENTS

The authors are grateful to Prof. G. Bocquet, Director Conservatoire et Jardin Botaniques, Switzerland for sending the Type specimens, to Dr. H. Persson for Icones Ineditae of Stephani's "Species Hepaticarum" and to Dr. Edith K. Cash, U.S.A. for the Latin rendering of the diagnosis. The authors are thankful to the University Grants Commission and Department of Science and Technology for financial assistance.

#### REFERENCES

- AMAKAWA, T. (1964). Notes on Japanese Hepaticae (13). *J. Jap. Bot.* **39** : 135-139.
- EVANS, A. W. (1908). Hepaticae of Puerto Rico IX. *Brachiolejeunea*, *Ptychocoleus*, *Archilejeunea*, *Leucolejeunea*, and *Anoplolejeunea*. *Bull. Torrey bot. Club.*, **35** : 155-178.
- GRADSTEIN, S. R. (1974). Studies on Lejeuneaceae, subfam. Ptychanthoideae. I. Nomenclature and taxonomy of *Ptychocoleus*, *Acrolejeunea* and *Schiffneriolejeunea*. *J. Hattori bot. Lab.* **38** : 327-336.
- GRADSTEIN, S. R. (1975). A taxonomic monograph on the genus *Acrolejeunea* (Hepaticae) with an arrangement of the genera of Ptychanthoideae (Studies on Lejeuneaceae, Subfam. Ptychanthoideae III). *Bryoph. Biblioth.* **4** : 1-162.
- MIZUTANI, M. (1961). A Revision of Japanese Lejeuneaceae. *J. Hattori bot. Lab.*, **24** : 115-302.
- MIZUTANI, M. (1976). Studies of little known Asiatic species of Hepaticae in the Stephani Herbarium 9. Some little known species of family Lejeuneaceae. *J. Hattori bot. Lab.*, **40** : 441-446.
- SCHUSTER, R. M. (1963). Studies on Antipodal Hepaticae 1. Annotated keys to the genera of Antipodal Hepaticae with special reference to New Zealand and Tasmania. *J. Hattori bot. Lab.* **26** : 185-309.
- SCHUSTER, R. M. & HATTORI, S. (1954). The oil-bodies of the Hepaticae II. The Lejeuneaceae. *J. Hattori bot. Lab.*, **11** : 11-86.
- STEPHANI, F. (1909-1912). *Species Hepaticarum* **4** : Geneve.
- STEPHANI, F. (1917-1924). *Species Hepaticarum* **6** : Geneve.
- UDAR, R. & NATH, V. (1977). Oil-bodies in south Indian Liverworts. *Geophytology*, **7** (1) : 50-53.
- VERDOORN, FR. (1934). Studien über asiatische Jubuleae De Frullanicesis xv. Die Lejeuneaceae Holostipae der Indomalaya unter Berücksichtigung sämtlicher aus Asien, Australien, Neu Seeland und Ozeanien angeführten Arten. *Ann. Bryol. (Suppl.)*, **4** : 40-192.